SEPTEMBER 1955 - VOLUME VII - No. 7

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## Science teaching in the primary school

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# Science teaching in the primary school

UNESCO, PARIS

## PREFACE

*This study is a natural by-product of Unesco's programme in the field of science teaching and it is hoped that it will aid in the international exchange of information on the teaching of science in primary schools. The publications abstracted or reported have been selected from materials held in the Secretariat or have been suggested by Member States in response to a request for information circulated in October 1954. Many of the abstracts themselves were prepared in Member States.*

*The study is divided into three parts. The first is a short essay on the present status of elementary science teaching, written in the Secretariat and based on available literature and statements supplied by correspondents in various countries. A short bibliographical list of items contributing to the essay is appended. The second part includes abstracts of important publications arranged in alphabetical order under their countries of origin. The third section lists sample elementary science texts and materials. This section is not by any means complete, but it does give some idea of materials available in the field. It also reflects the fact that some Member States have been particularly active in the preparation of materials for the teaching of science in the elementary school.*

*As mentioned above, the preparation of this issue has been possible only with the co-operation of authorities in Member States. The assistance of the following who prepared some of the abstracts as well as special short statement on the situation in their own countries, was particularly useful.*

*Australian National Advisory Committee for Unesco; Austrian Commission for Unesco; Commission Nationale Belge de l'Unesco; Danish National Commission for Unesco; Commission de la République française pour l'éducation, la science et la culture; German Commission for Unesco; Indian National Commission for Co-operation with Unesco; Norwegian National Commission for Unesco; Pakistan National Commission for Unesco; Unesco National Commission of the Philippines; South African National Commission for Unesco; Swedish National Commission for Unesco.*

*Dr. Paul E. Blackwood, U.S. Office of Education, Washington D.C., Mr. Glenn O. Blough, University of Maryland, College Park, Maryland; Dr. H.F. Boulind, Science Masters Association, Cambridge; Miss Katherine E. Hill, New York University, School of Education, New York; Dr. Ake Lodhammar, Stockholm; Mr. George Greisen Mallinson, Western Michigan College of Education, Kalamazoo, Michigan; Mrs. Jacqueline Buck Mallinson, Kalamazoo, Michigan; Dr. Holger Nilsson, Stockholm; Dr. Hans Steinbach, Vienna.*

## SCIENCE TEACHING IN THE PRIMARY SCHOOL

Science in one form or another is taught in the primary schools of more than 50 of the Member States of Unesco[1]+. These countries are widely distributed geographically and represent practically every level of technological development. Various titles are given to science courses in the primary school which however, fall into two categories usually designated as Nature Study and Elementary Science. It appears that in many places at present these two categories differ largely in name only, a fact that was not true two decades ago.

Nature study was taught at the primary level at a much earlier date than was elementary science and therefore it is more deeply rooted and more widely spread. The exact origin of nature study is somewhat obscure but it became well established in Europe through the teaching of such pioneers in education as Rousseau, Pestalozzi and Herbart[2]. Elementary science, on the other hand, had its origin in the United States of America more than a quarter of a century ago and is gradually replacing nature study in the primary schools there[3].

Through the influence of colonial expansion, nature study was carried to many parts of the world and has become well entrenched in such countries as Australia, South Africa, Equatorial Africa and New Zealand. Elementary science is also spreading and has been introduced in such countries as India, Thailand, Norway, Sweden and Pakistan.

### The aims and purposes of primary science

A survey of natural science teaching in the primary schools of 47 nations[1] lists five categories of aims: The acquisition of knowledge, the development of interest, the acquisition of mental discipline, the application of knowledge and the protection and love of nature. A more recent document on the teaching of nature study[2] while not listing aims, considers such topics as scientific method in the primary school, nature study as problem solving, children and problems, and the child's conception of the natural world.

There seems to be general agreement that science instruction at the primary level is not intended to give detailed technical information [4, 5, 6] but rather to contribute to the growth and development of the child. In the recent literature, as compared with that of a decade or more ago, there is an increasing emphasis placed on the development of problem-solving skills and desirable attitudes[7, 8, 9, 10] together with deeper appreciations and wider interests[11]. As stated by one contributor++, "In solving these problems it is expected that pupils will become more scientific in their attitudes. That is, they will be less likely to jump to conclusions, more likely to look at a matter from every side, go to reliable sources for information, and in other ways show that they are developing scientific ways of behaviour. A study of these problems is also expected to develop in children a greater appreciation of their environment and a wider interest in their surroundings".

### The selection of content for primary science

There is considerable evidence of a tendency in some countries to continue the long established principle of selecting the content for primary science largely from the specialized areas of the biological sciences. One source[1] makes the following comment: "In New Zealand .... a recent curriculum revision committee asked that more importance be given to nature study and less to elementary science, the latter being insufficiently adapted to the primary school level .... it would seem that this New Zealand demand represents by far the most general tendency".

In certain other countries, for the most part those of continental Europe, the content for the earlier years is selected from the biological aspects of the child's environment but later on "this instruction leads to the study of physics, i.e. to a knowledge of natural forces and laws as they reveal themselves in the child's daily life"+++.

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+ The numbers refer to the bibliographical list at the end of this essay.

++ Dr. Paul Blackwood, U.S. Office of Education, Washington, D.C.

+++ Contribution from Germany.

Other documentation obtained from sources where elementary science is taught contains statements such as the following:

"The content for science courses is generally taken from the following broad areas of the physical and biological environment: The Universe - the stars, the sun, the moon, the planets and their interrelationships: The Earth - its origin, mountain formation, weathering, erosion, etc. Conditions necessary to life; Living things; Physical and Chemical phenomena - light, sound, gravity, electricity, etc.; and Man's attempt to control his environment"(3).

It is important to note that, although such documents as the one just cited may greatly influence the content and organization of the elementary science programme, they do not, by any means produce a standardized course in all places. Some of the problems that have been emphasized cut across the boundaries of traditional science subject areas(12) e.g. conservation of natural resources(13), health and safety, living in an air age, and now, atomic energy and its uses(12).

One of the more recent sources in the field of the teaching of primary science(10) suggests that the syllabus can be made only by those "on the spot", the educationists and teachers who know local conditions; a syllabus must be related to the local climate, plants, animals, agriculture, crafts and industries.

Curriculum trends and procedures in primary science

There is a sharp trend away from rigid curricula in primary science and in the direction of providing more and more leeway for the teacher to plan with the pupils(1). In some places the teacher is simply instructed to take readily available things as topics, to direct the children's attention to whatever is within their immediate experience. In Switzerland it is the children themselves who decide just what plants and animals they will study.

Many different types of printed materials on the teaching of primary science have appeared in recent years. In the United States of America where elementary science has become well established, the appearance of several new science textbooks series marks an attempt by publishers to meet the growing interest of schools in elementary science teaching. Some of these series are listed in the bibliography at the end of this study.

During the past twenty years there has been an increased emphasis on relating the production of science curriculum materials to the in-service training of teachers. This trend is especially noticeable in the accounts of practices in the United States of America, the Philippines, and certain Scandinavian(27, 28) and south-east Asian countries. It is equally obvious in other areas of the curriculum and would seem to indicate a move in the direction of integrating the materials of instruction on the primary level.

A frequent practice is for a committee of teachers to take the leadership in planning the improvement of science teaching in a given locality. The members usually represent the primary schools in an area. The committee works closely with curriculum directors or supervisors in planning workshops for all teachers to attend, develops tentative outlines of science problems to be studied, builds up resource materials on these problems for teachers and children to use. Such committees work with the principal and staff of each school in an attempt to prepare science teaching suggestions and materials of direct help to each school.

It is not always the purpose of science committees to prepare materials. Often they plan other ways to help teachers gain a better understanding of the aims, methods and materials of science teaching. Among the many types of in-service programmes are:

(a) A one or two day workshop or conference to make all the teachers in a school system more conscious of the importance of teaching science, followed through the year by study groups of teachers working at different grade levels(26).

(b) A one or two week vacation workshop for those teachers who choose to attend it. Often college credit or professional credit is given for work in such workshops.

(c) A two hour workshop each week over a period of a half-year or more attended by those teachers who choose it. College and professional credit may be given.

(d) An individual school staff study programme to improve science teaching within the school.

For other, more varied plans for in-service education of teachers, see Helping children understand science by K. Freeman[14].

Trends in methods of teaching primary science

Teachers and supervisors of primary science, whether nature study or elementary science, are moving steadily away from formal teaching methods geared to the acquisition of facts alone[15]. The trend is definitely toward more flexible methods of the developmental type which place greater emphasis on the growth of the child and especially on increasing his ability to sense and solve the problems which confront him, as he seeks to adjust himself effectively to his environment[10, 11].

Summarizing returns from 47 countries on methods of instruction in primary science the 1949 Unesco-IBE report[1] states:

"In all countries it may be taken for granted that a teacher is expected to deal concretely with the subject, and to induce his pupils to be active. Recommendations to this effect sometimes go hand in hand with an explicit condemnation of formal teaching".

The same document quotes the nature study and natural science syllabus published by the Transvaal Department of Education in the Union of South Africa: "In this subject, method is more important than content in the early stages. Nature study can only accomplish its purposes when the teaching is in and through nature ... Here it is not so much the knowledge of facts that matters, as the path that is followed in acquiring the knowledge and the experiences that are gleaned on the way".

A recent document from Australia[2] emphasizes the trend in methods in nature study by stating: "Nature study presents the opportunity for the development of a scientific attitude and hence provides for an appreciation and understanding of scientific method ...

"The work should be organized round the solution of simple problems within the scope of the child's experience but endeavouring to widen this experience and involving a close study of natural material".

Stress is placed on the importance of the pupil having first-hand experience[4, 10, 16, 17, 18] and on the value of practical demonstration[2, 10, 19]. In addition to first-hand experience, it is recommended that basic texts should be read[2] as well as supplementary books, magazines, bulletins and other printed materials[11, 20], and further that the learning experience selected in each case should be the one that will be suitable and possible in a specific situation[4, 12, 14, 21].

As has been previously noted, the evidence clearly indicates that the problem approach is generally considered to be most effective[2, 9, 10, 11, 22]. Pupils raise problems, set up ways to solve them, carry out their plans and evaluate their efforts. In each process the teacher acts as a guide and exercises such leadership as is essential[10, 23].

The problem approach is recommended even though the starting point may vary. Some common ways of selecting a starting point are the incidental method, the planned unit of study and the subject core unit. In the incidental method[24] there is no prescribed course of study or procedure. The teacher takes a plant, animal, fossil or mechanical device which a child brings in, and uses it as a stimulus for furthering interests and activities. Experiences gained in this way are not generally accepted as constituting an adequate science programme.

In the planned unit of study approach[6, 14, 21] science topics are selected for certain grade levels and a plan is devised to build a basic programme with related topics that will equip the child with information and skills that are important to his understanding of the topic or problem. In this approach, learning units may be organized around topics, problems, science concepts or science principles[25].

In the subject core approach, any subject area may be the centre of study and other subjects radiate from it as they become related to the core subject. For example, the core subject may be social studies or health, and science topics are introduced as they contribute to an understanding of the central problem.

Despite the emphasis in much of the available documentation on first hand experience in the learning of primary science, there still remain many areas where there is a deep rooted tendency to regard it simply as another subject to be learned from a textbook, to be read about rather than to be experienced. Science teaching experts in the field have found numerous places where teachers prefer to read from a book about a plant or an animal rather than to lead the child to understanding through real problems. This again points up the idea that the factual material though perhaps important in itself, can best serve as a means to the end of pupil growth. It is a vehicle by means of which the child can be led step by step from the recognition of a problem through clear definition, hypothesis, observation, interpretation, and influence to conclusion and application. Only through the use of such a cycle of experiences repeated day after day in the classrooms, solving problems that are real to him, will the child acquire skill in observation and other abilities basic to a habit of critical thinking.

Experiment and observation are basic to the teaching of primary science through a problem approach. When living things are being studied there is usually an abundant supply of material for experiment and observation. On the other hand when problems are drawn from certain physical aspects of the environment of the child, there may be some difficulty. In recent years there has been a great deal written about the use of simple and improvised equipment as a basis for experiment and observation in primary science(4, 10). This material is of particular significance in the areas that are just becoming industrialized.

Summary

In the documentation examined for this study there seems to be considerable evidence that differences which existed between Nature Study and Elementary Science two or more decades ago are gradually disappearing and that there is a definite trend toward a meeting in purposes, content, and methods of instruction. Whereas in an earlier day the materials of nature study were selected largely from the area of biological sciences, there is an increasing tendency to include content selected from the physical sciences. There is also a trend in both Nature Study and Elementary Science to regard the growth and development of the pupil as the most important outcome of instruction and thus to place more and more emphasis on the development of habits of critical thinking, desirable attitudes, deep appreciations and abiding interests.

1. *International Conference on Public Education, 12th, Geneva, 1949. Introduction to natural science in primary schools. Paris, Geneva; Unesco, IBE; 1949. 171 p.

2. *Harris, Thistle J. The teaching of nature study; a practical guide for teachers in primary schools. Melbourne, Australian Council for Educational Research, 1954. 100 p.

3. *National Society for the Study of Education. Science education in American schools; forty-sixth yearbook, Part I. Chicago, University of Chicago Press, 1947. 306 p.

4. *Blough, Glenn O. and Huggett, Albert J. Elementary school science and how to teach it. New York, Dryden Press, 1951. 532 p.

5. *Craig, Gerald S. "The development of science in elementary schools". Teachers College Record, Vol. 49, No. 6, pp. 382-392. New York, March, 1948.

6. *Ragan, William B. Modern elementary curriculum. New York, Dryden Press, Inc., 1953. 570 p.

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* Abstracted below.

7. Dunning, Gordon M. "Developing critical thinking through elementary science". School Science and Mathematics, Vol. 51. pp. 61-63. Menasha, Wisc., January, 1951.

8. Ilgen, V. Carl. "Science for today's children". National Elementary Principal, Vol. 33, pp. 297-311. Washington D.C., September, 1953.

9. Shores, J. Harlan and Saupe, J.L. "Reading for problem-solving in science". Journal of Educational Psychology, Vol. 44. pp. 149-158. Baltimore, March 1953.

10. *Joseph, E.D. The teaching of science in tropical primary schools. London, Oxford University Press, 1953. 234 p. (Unesco handbooks on the teaching of science in tropical countries Vol. I).

11. *Heiss, Elwood D., Obourn, Ellsworth S. and Hoffman, Charles W. Modern science teaching. New York, Macmillan Company, 1950. 462 p.

12. *Burnett, R. Will. Teaching science in the elementary school. New York, Rinehart and Company, Inc., 1953. 541 p.

13. Guba, Anne. "Conservation concepts in elementary education". Journal of Education, Vol. 136, pp. 36-38. Boston, November, 1953.

14. *Freeman, Kenneth et al. Helping children understand science. Philadelphia. John C. Winston Company, 1954. 314 p.

15. *von Wyss, C. The teaching of nature study. London, A and C. Black Ltd., 1951. 102 p.

16. *Philips, H. and McInnes, F.C.J. Exploration in the junior school. London, University of London Press, 1950. 272 p. illus.

17. Daniel, Etheleen. "Science experiences for the up to nines" Childhood education, Vol. 26, pp. 304-308. Washington D.C., November, 1953.

18. *Ansari, A.D. and Latif, A. Roze marrah science. Lahore, Punjab Education Department, 1954. 164 p.

19. *Hutchinson, M.M. Children as naturalists. London, George Allen and Unwin Ltd., 1953. 193 p.

20. Mallinson, George Greisen and Mallinson, Lois Marion. A bibliography of reference books for elementary science. /Revised edition/. Washington, D.C., National Science Teachers Association, 1954. 42 p.

21. *Craig, Gerald S. Science for the elementary school teachers. Boston, Ginn and Company, 1947. 561 p.

22. *Zim, Herbert S. Science for teachers and children. Washington D.C., Association for Childhood Education International, 1953. 55 p.

23. Freeman, Kenneth E. "Evaluating elementary school science instruction". Science Teacher, Vol. 18, pp. 78-80. Washington D.C. March, 1951.

24. Zim, Herbert S. "Incidental science in the elementary classroom". Science Teacher, Vol. 19, pp. 17-19. Washington, D.C., February, 1952.

25. *Tweddle, T.A. The science teacher's handbook. London, Harrap and Co., Ltd., 1950. 249 p. illus.

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* Abstracted below.

26. Curtis, William C. "The improvement of instruction in elementary science". Science Education, Vol. 34, pp. 234-47. Washington D.C., October 1950.

27. *Berg, Anders et al. Naturen, laere-og lesebok for folkeskolen, Oslo, H. Aschehovg and Co., 1953. 320 p. illus.

28. *Holmsen, A. and Strøm, O. Naturlaere. Oslo, J.W. Cappelen, 1952. 120 p.

## GENERAL

1. International Conference on Public Education, 12th, Geneva, 1949. Introduction to natural science in primary schools. Paris, Geneva; Unesco, IBE, 1949. 171 p.

This is the basic document of the XIIth International Conference on Public Education convened jointly by the International Bureau of Education and Unesco in 1949. It is a compilation, interpretation and discussion of the replies from 47 nations to a questionnaire dealing with the place of natural science in the curriculum, curriculum and methods, teaching staff and other issues. The report gives a general comparative summary of returns under each of these headings and then lists the returns in full by country.

2. Joseph, E.D. The teaching of science in tropical primary schools. London, Oxford University Press, 1953. 230 p. Illus. (Unesco handbooks on the teaching of science in tropical countries, Vol. 1).

The book is divided into two parts. The first part deals with general problems concerning science teaching in the primary school, including the reasons for and aims of science teaching, and the teaching qualities, methods and materials required for the pursuit of these aims. The second part of the book outlines 6 years work for the primary school devoting a chapter to each year's work. As the author says, "Part II, which covers the treatment of a scheme of work, begins with an outline of the grouping of subject matter. This is a summary of the topics considered, but it is NOT a syllabus ... The outline has been carefully planned to serve as a basis for the development of general science syllabuses, for different countries and localities, according to their needs. A detailed syllabus can be made only by those 'on the spot', the educationists and teachers who know local conditions: a syllabus must be related to the local climate, plants and animals, agriculture, crafts and industries, etc. The teacher must first examine the syllabus he has to use in his school; then he can refer to the outline in this book and quickly find the topics he wants. Even if they are given for a different year's work in the syllabus, he can easily see how they fit into the general scheme".

3. Stephenson, J.P. Suggestions for science teachers in devastated countries. Paris, Unesco, 1948. 87 p.

This booklet has gone through several editions and has been reprinted in many languages. It deals with the making of simple equipment for such topics as astronomy, weather, measurement and properties of matter, heat, light, magnetism, electricity, chemistry and biology. Sections on science teaching, general science, science without apparatus, visual aids and laboratory receipts, charts and tables are also included. This is a helpful handbook for primary science teachers who do not have equipment available for teaching. A revised and enlarged edition of this book is planned for 1956.

4. Unesco. The construction of laboratory apparatus for schools. Series I - Elementary. Paris, 1953. 80 drawings.

Each plate in this portfolio of eighty workshop drawings of standard science equipment is a complete engineering drawing of a single piece of apparatus with all parts and dimensions. Lists of materials needed for construction, suggestions for use and detailed instructions of methods of construction are also given. These workshop drawings can be used in vocational or technical schools with shops or by local craftsmen. Through their

use a country can provideworth-whiletraining projects for students in vocational or technical schools and at the same time secure needed science equipment at a price that is far below that of foreign markets. A second portfolio, Series II, consisting of 76 additional drawings is now available for distribution.

5. Unesco. Inventories of apparatus and materials for teaching science Volume I. Primary, Secondary and Vocational Schools. Paris, Unesco, 1950. 92 p.

In part one of this document will be found a general introductory statement on the place of elementary science in the curriculum. This is followed by a typical course outline arranged both by topic and by age grouping and the types of classroom experiences appropriate for different topics. Perhaps the main feature is a listing of permanent equipment and consumable supplies for a primary school of 200 pupils. Quantities and prices are also included.

## AUSTRALIA

6. Harris, Thistle Y. Handbook of suggestions for teachers - William Brooks and Co., Sydney, 1945. 100 p. Companion Volume to Nature Problems.

In this book information for the teacher covering the units outlined in Nature Problems is given. In addition to this, the general teaching of the subject is discussed and methods of teaching various aspects of the work outlined. A bibliography is also included.

7. Nature problems; a book of nature study for young Australians. William Brooks and Co. Ltd., Sydney, 1948.

This book consists of 8 units of work so arranged that the young student will be introduced to methods of research along particular lines. The units are:- Living things. From a study of this unit children should learn the characteristics of living things and be able to distinguish them from non-living; Can you tell a plant from an animal? Giving the characteristics and distinguishing features of both types of living things; How do living things protect themselves? Some of the methods used by plants and animals in their defence against both physical and biological factors; Why do living things use oxygen? By experiment children discover the properties of oxygen and then how it is used in respiration, both by plants and by animals; How do plants and animals get their food? Plant products, methods of food manufacture in the green parts of plants and the relations of plants and animals to one another are examined; How do living things make plants and animals like themselves? The reproduction of plants by seeds is followed by observation of germination and pollination. Fertilization and the formation of fruits is discussed, and the dissemination of seeds and fruits. Development of eggs of frogs, moths, butterflies and other insects is followed throughout the life history. The reproduction of viviparous animals is discussed; What sort of plants does Australia produce? Various types of Australian vegetation such as brush, open forest, semi-desert are described. Conservation is discussed and some of the protected plants described; What sort of animals does Australia produce? Marsupials and monotremes are described and some reasons for their presence in Australia advanced. Necessity for and methods of protection are discussed.

8. _____. The teaching of nature study; a practical guide for teachers in primary schools. Melbourne, Australian Council for Educational Research, 1954. 100 p.

A summary report of an investigation into the teaching of nature study in the primary schools of New South Wales and the conclusions reached. The author traces the child's changing concept of his natural environment and arrives thus at a pattern for teaching this basic subject. In regard to methods of teaching the following aspects of the work are dealt with: Field work - considered to be the core round which the programme should be built. The apparently meagre resources of a metropolitan or city school ground in a restricted area are discussed, as well as various types of field studies and organization,

including group work. Experiments - the necessity for children to devise and carry out experiments is considered essential; conclusions to be reached from experimental work by children and apparatus needed are also discussed. Recording - the importance of the use of recording in this subject for the purpose of increasing accuracy of observation is stressed and various methods of recording are described. Programme making - the organization of work in units, the conclusions to be drawn from observations and the evaluation of the work are discussed. Conservation - the need for conservation and guiding principles for conservation teaching are laid down. Testing - various methods of testing are reviewed and general conclusions and recommendations are given for the general treatment of the subject throughout the primary school courses.

9. Leach, J.A. Australian nature studies - (Revised ed.) Melbourne, MacMilland & Co., 1951. 525 p. illus.

A source-book for teachers and others interested in nature study. The book contains three main sections. Part 1 covers plant life and under the following headings: seeds and their development, a study of food, the breathing of plants, leaf studies, the root, the stem, plants feel, plants climb, parasites, bud studies, the flower, fruits and seed scattering, how plants spread other than by seeds, and food stores.

General plant studies follow of seaweeds, mushrooms, ferns, etc.

Part 2 deals with animal life and includes chapters on the lower invertebrates, arthropode, mollusca, spiny-skinned animals, lower vertebrate animals, certain fishes, the frog, reptiles, the bird and mammals.

Part 3 contains general studies with chapters on rock studies, shore studies, the action of wind, the action of running water, lake studies, soil erosion, springs and wells, the soil, water studies, the surface of water and pond life.

The treatment is as systematic as the arrangement within Parts 1 and 2 suggests, and is popular rather than technical. Local names are used where practicable; generic names are added here and there. The material covered is not restricted to indigenous fauna and flora: one of the great advantages of this book is the wide coverage given to the plants and animals of the Australian bushland. Copious sketches assist materially in the task of identification. Numerous experiments are suggested in chapters where the material is suitable for experimentation.

## AUSTRIA

10. Steinbach, Hans. Lehrbuch der Naturgeschichte für die Osterreichischen Hauptschulen und für die Unterstufen der Osterreichischen Mittelschulen. Graz-Wien, Verlag Leykam, 1954. 4 vols.

In accordance with the prescribed curriculum, Part 1 contains sections dealing, respectively, with the most important parts of the human body, mammals and birds, and simply constructed flowering plants. Part 2 deals with reptiles, frogs, fish - echinodermata, molluscs; flowering plants of a more complicated construction, groups of acotyledons. Part 3 covers articulated animals, worms, coelenterata, antediluvian animals; other flowering plants, seaweeds, mushrooms, mosses, lichens; physiological observations. Part 4 reverts to the human body in more detail and gives general outlines of mineralogy and geology; plant groups and communities of living things; simple facts concerning trades connected with the production of raw materials.

A part of each section deals with the natural phenomenon in question as follows: 1. Introduction (preparation); this includes the appreciation of the results of the exercises set for pupils during previous lessons; each pupil undertakes, for himself, investigations or tasks for which he has the required opportunity and inclination; in this way, all the pupils form a team and their individual reports can together constitute a single,

comprehensive report. Pupils are generally required to select their tasks on the basis of their work. 2. Analysis: preparation and presentation of the material concerned. 3. Synthesis: recapitulation. (There is a recommendation to this effect at the end of the separate sections of the first, second and third volumes; pupils of the fourth class are already able to draw up such summaries by themselves). 4. Practical exercises gradually suggest themselves, when the subject concerned is properly taught. In accordance with the existing principles of Austrian vocational guidance schools, special importance is attached to the socio-moral education of the pupils: love of plants and animals, humanity in a high degree, and the uncompromising protection of nature. To the latter it is suggested that the greatest attention must be paid, owing to the very grave dangers that now menace mankind as a result of the great errors committed in this field.

The book is richly illustrated with "detailed" sketches.

## BELGIUM

11. Chaput, F. Méthodologie de l'enseignement des sciences naturelles (Methodology of Natural Science Teaching). Liège, Desoer, 1952. 157 p.

Following an introduction by Mr. Dutrieux on the guiding principles of rural education, the author deals with general principles of methodology, different forms of education, and various teaching processes, illustrated by examples and model lessons; he then makes some practical suggestions concerning the preparation and evaluation of lessons. Next he discusses the principles on which natural science teaching should, in his opinion be based. The author upholds the "biological" method advocated by Dévaud and advises frequent recourse to the study of nature itself.

The work closes with a treatise entitled "Natural Sciences and Humanism", in which attention is drawn to the great value of a sound natural science teaching as a form of intellectual training and to the important part played by the teacher, who should, above all, be an awakener of minds.

12. Natalis, E. Méthodologie de l'histoire naturelle (Methodology of Natural History Teaching), Liège, Dessain, 1951. 243 p.

Use in teaching natural history of the psychological method advocated by the author in the four preceding volumes of his Méthodologie de l'enseignement primaire (Methodology of Primary Education). As far as nature study is concerned, E. Natalis closely follows the various stages of a child's development. Passing on from the first stage of purely emotional observation, the child imperceptibly begins to reason as he observes and then again moves on to draw conclusions from what he sees. In this connexion, the author emphasizes the need first of all to see and understand a living creature in its natural environment. Following on from these theoretical statements are several chapters written from a practical standpoint: study of a living creature, evolving of syntheses, study of the inanimate world, building up of material, etc.

13. Verhaert, A. Studie van de natuur in de natuur of de oecologische methode in het natuurwetenschappelijk onderricht (Nature Study in Natural Surroundings or the Ecological Method in Natural Science Teaching). Brussels, Christen Onderwijzersverbond, 1950. 140 p.

According to Tansley, ecology is nature study in the highest meaning of the term. It would therefore be desirable for the ecological method, which is already employed in universities and secondary schools, to be introduced into primary schools; moreover the study of environment provides an opportunity for this.

It is obvious that there must be some adaptation to a child's mental powers, but the ecological method lends itself well to that purpose; it also has undoubted advantages from the scientific and educational points of view. It gives greater depth to natural science

teaching and, as a working method, it provides a good intellectual training and awakens a love of nature, besides helping pupils to appreciate work at its true value and to acquire a sense of obligation towards society. It thus contributes to the formation of independent personalities.

## EGYPT

14. Kotb, Yusef Salah El-Din, Science and science education in Egyptian society. New York, Bureau of Publications, Teachers College, Columbia University, 1951. 250 p.

This doctoral dissertion sets forth the background of science in Egypt in the following chapters: Science, Society and Education, Egyptian Society, Science Education in the Service of the Egyptian Society and The Rôle of Science in Solving the Social Problems in Egypt. In the final chapter, Values for Science Education in Egypt, the author makes certain proposals for a science programme in the primary and secondary schools of the country.

## GERMAN FEDERAL REPUBLIC

15. Der junge Naturfreund. Ein Arbeitsbuch für den naturkundlichen Unterricht. Neu bearbeitet von Walter Emeiss, Walter Burmeister, Otto G. Meier. Hamburg, Pinneberg, Frankfurt/M, Otto Salle Verlag, 1953-54. 4 vol.

The teaching of biology is based entirely on the study of nature on "the native soil" (Heimatliche Natur). The term "native" is not, here, used in a narrow sense. The subject-matter is arranged according to natural environments. The book, as an essentially practical one, emphasizes the importance of careful observation work and trains the pupil, through clear and methodical thinking, to attain to complete objectivity. The various volumes stimulate the child's reverence for all forms of life, so that it becomes readily accessible to the ideas of hygiene, animal protection and the protection of nature. The work is abundantly illustrated with sketches, diagrams and pictures. Constant reference is made to educational films, filmstrips and class reading material.

16. Grupe, Heinrich. Naturkunde in der Volksschule. 2. Auflage. Hannover, Wissenschaftliche Verlagsanstalt, 1949. 135 p.

The author first describes his studies of nature as a country boy. Thanks to these studies he was later to take a deep interest in animals and plants. In the following chapters, the description of the various phases of his development is linked with the description of his experience as a teacher and with that of the evolution of methods in natural science teaching since 1872. The headings of the various chapters correspond to this manner of presentation: Natural science teaching in a one-class village school, in a pre-1900 advanced class, in rural schools towards 1900, in a large city school after 1900, and in a training college (Pädagogische Akademie).

The most comprehensive chapter - "How the natural sciences should be taught in a modern country school" - is a synthesis of both theoretical and practical knowledge, and describes the present situation with regard to the methods of natural science teaching.

17. Maier, Eugen. Naturlehre für Volksschulen. Ein praktisches Arbeitsbuch für Volks-und Mittelschulen. Stuttgart, Mundus Verlag, 1941-1951. 2 vol.

Taking their everyday experience (tram rides, cameras, pocket-lamps, etc.) as his starting-point, the author familiarizes the pupils with the various processes of mechanics, optics and electricity. On the other hand, the efforts to solve the mysteries of the changes in matter lead back to the observation and investigation of the child's surrounding world in general, so that chemistry appears not as something abstracted from nature and the world, but as something essentially bound up with the home, the kitchen, the workshop, the factory or the farm.

## NEW ZEALAND

18. Beggs, D. Nature study; a handbook for teachers. Wellington, New Zealand. Department of Education, 1954. 268 p. illus.

Deals with the general approach to nature study, the class treatment of topics, teaching indoors and outdoors, school grounds and school gardens. All the topics to be found in the New Zealand nature study course are then discussed in detail. Practical suggestions for teaching are included as well as 57 excellent illustrations.

## NORWAY

19. Berg, Anders et al. Naturen, laere- og lesebok for folkeskolen. Oslo, H. Aschehoug & Co. 1953. 320 p. illus.

The book is divided into three main parts: animals and plants; physics and chemistry, and hygienics.

The section on animals and plants is based on the principle of regional distribution, and begins with what is best known to the children, viz. "Animals in and around our homes". It goes on to the fields and meadows, the forest, the mountains, bogs and fresh water, the sea, and so on. Most of the important animals and plants, of higher and lower order, are in a natural way introduced into this system. The cultivated plants, however, are treated in a separate section, as are also animals and plants from foreign countries.

In a chapter called "More about plants and animals", the author mentions the most important facts about the anatomy and physiology of the plants, the reproduction systems of animals, and about the fauna through the ages. Finally there is a systematic survey of the animal kingdom and the vegetable kingdom, with reference to the pages where the different animals and plants have been treated. Simple questions and experiments to be carried out by the pupils have been introduced in the text where appropriate. At the end of this section some questions for revision are given.

The main part of the book, physics and chemistry, deals first with the theory of heat and then with mechanics, sound, light, magnetism, electricity, and lastly with machines. This part constitutes a fairly comprehensive introduction to the general physical phenomena; where it is appropriate the pupils are brought into closer contact with the problems by means of experiments to be carried out by themselves or by the teacher. The section dealing with chemistry does not treat a great number of chemical compounds, but enough to give the pupils an idea of what chemistry is. Special emphasis is laid upon substances which are important for organic life.

In the third part, hygienics, the first section deals quite thoroughly with the human body, its anatomy and physiology. The following section covers health rules, with general information concerning food, drinks, tobacco, alcohol, infection, first-aid, artificial respiration etc.

20. Holmsen, A. and Strøm, O. Naturhistorie, 14th edition, Oslo, J.W. Cappelen, 1954. 176 p.

This is one of the most commonly used textbooks on biology for elementary schools. Content and layout follow the "Normalplan", i.e. the curriculum plans approved by the Ministry of Education.

The animals described are mainly those existing in Norway and those most important to mankind, either domesticated or wild. Some foreign animals are mentioned, in general such common ones that the children will come across them when reading of foreign countries.

The botany section gives a fairly detailed description of some main types of the Norwegian vegetation. The foreign plants described are primarily those which are of the greatest economic value to men, e.g. rice, corn, cotton, coffee, tea, etc.

The descriptions of animals and plants are illustrated by numerous pictures, some of which are in colour. The biology of animals and plants is treated partly in connexion with the description of the various species, partly in special chapters. A special chapter also gives a brief survey of animals and plants in prehistoric time (paleontology).

In accordance with modern teaching principles the book contains study tests at the end of the chapters.

21. Holmsen, A. and Strøm, O. Naturlaere. Oslo, J.W. Cappelen, 1952. 120 p.

Content and layout follow the "Normalplan" i.e. the curriculum plans for Elementary Schools approved by the Ministry of Education. According to this plan "the pupils shall acquire some knowledge of the physical and chemical activities by observing how these forces operate in daily life, and through experiments conducted, as far as possible, by the pupils themselves".

The experiments chosen, therefore, are so simple that most of them can be made by the pupils. Some, however, have to be conducted by the teacher, but in such a way that the pupils can co-operate.

At the end of the different chapters there are study tests and questions.

The Chemistry and the Physics sections are illustrated by line drawings placed in the margin to allow the text to run without interruption and to make for ease in reading.

## PAKISTAN

22. Ansari, A.D. and Latif, A. Roze marrah science. Lahore, Punjab, Education Department, 1954. 164 p.

This book in Urdu has been especially written for the guidance of the school teachers in charge of the first three classes in the primary schools of the province. It is a collection of extremely simple methods and illustrations for teaching the basic principles of science to young children. Examples have been taken from their everyday life. It also covers child psychology, the need and objectives of science teaching, laboratory and science apparatus and science tests. The importance of teaching this subject according to the capabilities of students of this age is stressed.

23. Khan F.M., Hasan, I. and Latif A. Nasab-e-science. Punjab Education Department, Lahore, 1954. 185 p.

The book in Urdu covers in detail the curricula in science for primary schools. It is intended for Junior Vernacular teachers of science in the primary schools of the Punjab. The topics discussed include: matter, its division into solids, liquids and gases; air its cleanliness, respiration and burning; water, its properties, general impurities in river and canal waters and their removal, freezing of water, evaporation, boiling, presence of water vapour in air and rusting of iron; hygiene, health, food, necessities of physical health, diseases; animals, insects, plants and crops. Well illustrated.

## SPAIN

24. "La enseñanza de las ciencias naturales". Bordón; revista de la Sociedad Española de pedagogía, Tomo V. No. 34. Febrero 1953. 231 p. Madrid, Instituto "San José de Calasanz".

This special issue of Bordón is devoted to the teaching of natural sciences at the elementary school level. It includes articles on natural sciences in education, the selection and arrangement of the content of elementary science teaching, out-of-school activities related to the teaching of science, evaluation of school achievement and learning units in the teaching of science, agriculture and home industries in the primary school. A very thorough bibliography on reference and guidance materials for elementary science teaching completes the "special" part of the issue.

## UNION OF SOVIET SOCIALIST REPUBLICS

25. Pčelko, A.S. and Zavitaev, P.A. Elementy politekhničeskogo obučenija v načal'noj škole. Metodičeskoe posobie. "Elementary polytechnical training in primary schools". Moskva, Izdatel'stvo Akademii pedagogičeskikh nauk RSFSR, 1953.

In accordance with the decisions of the Nineteenth Congress of the Communist Party of the Union of Soviet Socialist Republics, polytechnical education is to be introduced into all Soviet schools from 1954 onwards. Every school is therefore required to prepare a definite plan of study, allowing for the needs of practical training and general culture alike.

The purpose of polytechnical education is to bridge the gap between theory and practical life. It is therefore possible only if general education is well organized.

The author gives some explanations on the polytechnical curriculum in primary schools. He advocates the following activities for pupils: practical studies during school hours; practical work on the spot; excursions and film-showings; occupations outside school, organized by pupils' clubs; reading outside school hours. Teachers, for their part, are requested to give an account of their personal experience and to read books specially prepared for their benefit. The author deals with each of these points in a separate chapter.

The methodological handbook by Pčelko and Zaviaef was published in the Library series for professors at the Academy of Pedagogy of the RSFSR.

## UNITED KINGDOM

26. Branson, J.M. The study of the soil. London, School Nature Study Union, 1950. 7 p. illus.

"The fact that we all live on the soil of the Earth and that this soil is a precious and easily wasted asset, is a good reason for including some study of the soil in any school syllabus. To the country child it is obvious enough that the soil is the source of all food, but the town child has probably not noticed it except to describe it as 'dirt'. For children of junior school age simple ideas of soils derived from the underlying rocks and of the existence of different kinds of soils, sandy, clay and peaty, will be noticed in local study either in natural history or geography. Many of the simple experiments may be carried out, even if only as demonstrations by the teacher. The best beginning is probably made by examining soil samples from the school garden, or one nearby. Children may then be asked to bring samples."

27. Hutchinson, M.M. Children as naturalists. London, George Allen and Unwin Ltd., 1953. 193 p. illus.

"Part One of this little book deals with the scope of work which may be touched upon, and the attitude adopted in different age groups throughout the junior school when they are turned loose and learn their nature study out of doors. It must be emphasized, however, that no hard and fast line between these groups may be drawn. The children's interest is what matters ... Part Two deals in more detail with different aspects of nature study and attempts to answer briefly for the teacher a few of the many questions raised on a nature ramble and which are not to be found in the popular books on the subject."

28. Philips H. and McInnes F.J.C. Exploration in the junior school. London, University of London Press, 1950. 272 p. illus.

"This book attempts to describe some of the experiences which resulted from the undoubted interest of children in exploring their immediate environment and which stimulated an attitude of whole-hearted endeavour. It also sets out, as simply as possible, some of the conditions of school and classroom, and something of the attitudes and knowledge that are required of the teacher, that we have found in practice to be valuable in encouraging children's efforts.

Our experience in this direction has been gained with children in large classes, working often in cramped conditions, and perhaps this may encourage other teachers, working under similar difficulties, to be undaunted in exploring the possibilities of the environment as a stimulus to activity. We hope, too, that students in training or inexperienced teachers may find something here to help them in their own discoveries of children's needs and in their search for the best means of satisfying them."

29. Tweddle, T.A. The science teacher's handbook. London, Harrap and Co. Ltd., 1950. 249 p. illus.

This handbook is intended to accompany Everyday science topics, Books I, II & III, by the same author. It states that the pupils should be led to realize the important part played by science in the modern world, and should acquire some knowledge which will enable them to deal with its application. " ... By the topic method of teaching we make use of things and phenomena met with in the everyday life of the pupils. Interest is easily aroused, knowledge of practical importance is imparted, and the relative importance of the scientific principles involved is soon realized. It is the method used by a practical man when teaching out of school. He attacks the topic directly, and the principles come in only when needed. ... far too much time has been spent on the verification of principles discovered by scientists long ago. Pupils should start at the point reached by scientists after generations of thought and labour. By the topic method of teaching, fundamental principles keep cropping up over and over again, and are explained and tested only in sufficient detail to give a clear understanding of the matter in hand. Excellent revision is thus provided, and the relative importance of the principles is understood."

30. von Wyss, C. The teaching of nature study. London, A. and C. Black Ltd., 1951. 102 p.

The author states that the first stage of teaching nature study applies to children before the age of nine or ten years. It is characterized by great curiosity, as regards the outside world, and especially as regards other living beings, whose behaviour rather than appearance excites interest. Attention is rarely sustained unless it is accompanied by play, especially such play as will involve bodily activity. To make a snail crawl up a stick, to give a rabbit something to eat, to make a fairy doll out of a poppy, are some of the characteristic reactions of the young scientist. The work in the lessons at this stage should be quite informal and anything like systematic questioning on the part of the teacher should be avoided. The spontaneous comments, conversations, and questions, the expression of fear, wonder, and joy should all be as unchecked as the orderly life of the community will allow. If anything like direction and definiteness is thought advisable, drawing and colouring of pictures will provide suitable opportunity.

## UNITED STATES OF AMERICA

31. Blough, Glenn O. and Blackwood, Paul E., Science teaching in rural and small town schools. Washington, D.C., U.S. Government Printing Office, 1949. 55 p.

This bulletin points out that the content and methods of science are useful to children and adults to the extent that they contribute to better living throughout the world. Teachers are urged to help girls and boys develop science generalizations which will aid them in their day-to-day living, to help them solve their own problems, to grow in open-mindedness and tolerance of each other's point of view, and to become more appreciative of the world around them.

With these thoughts in mind, descriptions of good classroom science experiences with children are given. In addition, some of the needs and interests of children are outlined, and resources appearing in the natural environment are suggested. Attention is drawn to the place of experimentation, reading, observing, field trips, and visual aids in the programme of science in the elementary school. A valuable list of materials and a selected list of books for teachers and children are also given.

32. Blough, Glenn O. and Campbell, Marjorie H. Making and using classroom science materials in the elementary school. New York, Dryden Press, 1954. 229 p.

Intended to help teachers who have had no experience in improvising simple equipment for pupils experiment in primary schools. It is not simply a book of instructions on how to make apparatus but includes many useful hints on the use and integration of materials. There are chapters on: The Science Room and the Science Teacher; Animals and Plants in the Classroom; The Earth and Sky; Air, Weather and Aviation; Magnetism and Electricity; Sound, Light and Heat; and Machines. Sections are also included on Sources of Further Information, Sources of Materials and a detailed bibliography.

33. Blough, Glenn O. and Huggett, Albert J., Elementary school science and how to teach it. New York, Dryden Press, 1951. 532 p.

Part one of this comprehensive work is devoted to objectives and general methods for the teaching of science in the elementary school. Parts two, three and four serve to elaborate teacher-background material and suggest specific procedures for teaching in the following areas: the earth and the universe, living things, matter and energy.

The authors suggest that a teacher's goal today is to help a child interpret his environment by employing scientific, systematic methods of problem solving, being careful and accurate as he proceeds in his interpretation. They point out that a shift of emphasis in the teaching of science in the elementary school has taken place during the past thirty years or so. Formerly, the identification of objects from the environment was held to be important as a major goal; single objects were studied carefully without much relation to their environment; attention was concentrated on living rather than the non-living phenomena of the environment.

Today, identification of and study of single objects is important only as this aids a child in interpreting phenomena of the environment. Teachers are urged to use the total environment as a laboratory for study rather than to concentrate on a part of it, thus enabling children to enlarge their picture of the world about them.

Several interesting nation-wide trends are suggested by the authors. They may be summarized as follows: There is increasing emphasis on science as a part of the elementary school programme, borne out by the development of many curriculum guides; science experiences involving the immediate environment are being used more widely; increasing effort is being employed to take into account the varying needs, interests, and abilities of children.

34. Burnett, R. Will. Teaching science in the elementary school. New York, Rinehart and Company, Inc., 1953. 541 p.

The author assures teachers at the outset that the teaching of science in the elementary school does not necessarily involve the use of highly technical terms and complex mathematical equations or the memorization of minute facts. Rather, the study of science is viewed as experiencing the natural environment by investigating phenomena with enthusiasm and accuracy. It is hoped that children engaged in such a process will develop critical minds, especially with regard to the use of scientific findings in modern society.

In aiding children to come to a better understanding of their environment, teachers are urged to provide experiences, rather than mere reading about science. To this end, Part II of this book is devoted to a description of science experiences in which children might engage and to background source material for the teacher. The areas considered in this section include: learning about the nature and meaning of science: learning about the atmosphere and weather; about electricity and its uses; learning about energy and the use we make of it; about atomic energy and the nature of matter; about the earth, other plants, and stars; learning about the earth and its changes; about living things; and learning about ourselves.

Photographs of children engaged in science activities are used effectively throughout this source book to aid teachers in visualizing science experiences. In addition, a valuable section is devoted to facilities and equipment for teaching science in the elementary school. A selected, annotated bibliography for teachers and children follows each section.

35. Burrows, Alvina T., Teaching children in the middle grades. Boston, D.C. Heath and Co., 1952. 280 p.

Since this book deals with the characteristics of and possible curriculum experiences for children of ages eight to twelve, it is natural that a consideration of science should be a part of the total picture. The author stresses the fact that children in the middle grades wish to enlarge their knowledge and understanding of the world around them. True, depth of information and purposes differ with the individuals concerned, but it is also true that an entire group can work co-operatively, with purpose and vigour, as it solves problems related to natural phenomena, especially under the guidance of a well-informed, sensitive, and enthusiastic teacher. Help is given in suggesting methods for dealing with content areas, one of which is elementary science.

A valuable chapter, "A third grade studies science", describes the day-by-day experiences of a group of eight-year-olds engaged in a study of geological materials. How the study was organized, the ways individuals gained and shared information, the types of experiences used are presented, together with work charts, a page from a child's notebook, the teacher's checklist of help to be given to individual children, and a class check-list for use in planning a programme for parents.

The generalized consideration of content areas and the specialized consideration of an area in science should be of special help to the classroom teacher who is anxious to incorporate science learnings in his programme.

36. Craig, Gerald S., "The development of science in elementary schools". Teachers College Record, Vol. 49, No. 6, p. 382-392. New York, March 1948.

The intent of this article is threefold: to reconsider the purposes elementary school science should serve, to consider the contribution elementary school science should make to the growth of boys and girls, and to consider the competencies classroom teachers should have in order to teach elementary science.

The concern of teachers for preparing youth in a democracy to shoulder social responsibility must be realized. In this setting, it is clear that science in the elementary school can make a contribution as it affords children opportunities to develop resourcefulness and intelligent social behaviour. It is of primary importance that the members of

a society realize that all citizens are responsible for determining how the contributions of science will be utilized. For this reason, elementary science must be designed for all children, not merely a selected few.

It is clear that boys and girls are constantly interpreting their environment. Without guidance, these interpretations may lead to fear, dogmatism, or prejudice. Guiding the learning of children need not dampen their curiosity, their vigour, their exploration, their resourcefulness. Rather, a teacher who considers the capacities and abilities of each child will build upon these capacities and abilities in encouraging him to utilize these natural drives.

Teachers can learn as they work with children in elementary science. It is suggested that perhaps the most effective teaching is done when children and teacher learn together.

37. Craig, Gerald S. Science for the elementary-school teacher. Boston, Ginn and Company, 1947. 561 p.

This is a valuable source book for teachers in the elementary school, not only for background subject matter but for philosophy of science teaching and for possible experiences as well.

Part one is devoted to a discussion of science and elementary education, science and the classroom teacher, and science and the child. It is suggested that the following criteria be used to select objectives for elementary-school science: Does the objective help children understand how scientific concepts have modified man's thinking concerning his environment and the place of the scientific method in society?; Does the objective further children's understanding as to how science should function in society if man is to continue to exist and advance?; and Does the objective conform to scientific understandings that are essential in the interpretation of natural phenomena which challenge the thinking of children? Emphasis is placed on the fact that children have certain conceptions of their environment. These conceptions differ for each individual, and each individual enlarges his conceptions at his own rate and on the basis of his own experiences.

Part two is concerned with the earth and the universe; part three with the life on the earth; part four with the energy of the universe, and part five with using science to make a better world. Each chapter contains many illustrations and bibliography. Part six is a valuable addition, containing material which might be used in planning a curriculum in science for children, ages five to twelve.

38. Freeman, Kenneth, et al. Helping children understand science. Philadelphia, John C. Winston Company, 1954. 314 p.

This book is designed to help elementary teachers improve their skill in teaching science. It sets forth the commonly accepted purposes for teaching science and shows how these relate to the developmental characteristics of elementary school children. The suggestions are built around the types of help which elementary teachers seek in order to do a better job of teaching. For example, one chapter deals with ways of planning and organizing for improved teaching. The book deals also with how to develop and use a planned course of study, how to use community resources for science teaching, how to equip the schoolroom for science, how to make best use of audio-visual aids and how to evaluate the science programme. Throughout, the importance of relating science experiences to the total elementary school programme and to the overall experience of children is emphasized.

39. Greenlee, Julian. Teaching science to children. Dubuque, Iowa, William C. Brown Company, 1951. 58 p.

"Understanding children", the first chapter of this practical and helpful little book, suggests that teachers become as well acquainted with children in their group as possible through contacts with the children's parents, observing children's choice of activities, listening to their conversations, observing children's explorations, providing for experimenting, setting up flexible programmes affording opportunities for individual as well as group participation, keeping records of children's development, and helping children

maintain their self-respect. The author indicates that science experiences furnish innumerable opportunities for children to solve problems which are significant to them. In working through these experiences with children, teachers are better able to guide them as they grow and develop.

The major portion of the book presents science experiences which may be used with young children. These experiences are concerned with living things, soils and rocks, space concepts, mechanics, the atmosphere, and temperature controls.

No experience is indicated as being suitable for a particular age level or for use in a particular context. Rather, the experiences are presented to the teacher for his use with children, in whatever way he deems best.

40. Heiss, Elwood D., Obourn, Ellsworth S. and Hoffman, Charles W. Modern science teaching. New York, Macmillan Company, 1950. 462 p.

In this generalized treatment, science in the elementary school is considered as only one facet of a total science programme extending from kindergarten through the high school. The goal is stressed of modifying individual behaviour patterns so that the individual's adjustments to life problems are more satisfying and effective. To this end, it is important that teachers realize the necessity of using in their work with children such rich science-content areas as health, safety, conservation, and consumership. The rôles of appreciation, of scientific attitudes, of problem solving, and of interests in science learning are treated thoroughly.

A consideration of the characteristics of elementary-school children leads to the proposition that content should be selected in relation to broad scientific concepts and principles, to the adjustment needs of children, to children's interests, to individual patterns of growth and development, and to level of concept or principle difficulty. Science content will differ from age-level to age-level and from school to school, for where a child lives and the experiences he has will influence profoundly his adjustment needs, his interests, and his patterns of growth and development. The unifying factors in children's science experiences are the broad principles and concepts of science itself.

Practical guidance for the classroom teacher is also given. Here the importance of teacher planning and pupil-teacher planning is emphasized.

Other sections furnish excellent information concerning an elementary science work-room, community resources including excursions, and audio-visual materials. Classroom teachers will find this a source for answering such questions as "How could I make cellophane lantern slides?", "What materials will we need for constructing a classroom diorama?", and "How may we build an aquarium?".

41. National Society for the Study of Education. Science education in American schools, forty-sixth yearbook, Part I. Chicago, University of Chicago Press, 1947. 306 p.

Section II of this publication, entitled "Science in the Elementary School", is the result of the collaboration of some twenty educators with special interest in this aspect of the curriculum. Attention is directed to the following areas: background of the curriculum in science, organization of the curriculum in science, materials and methods of teaching science in the elementary school, judging the results of instruction in elementary science, resource materials for elementary science in rural and urban schools, and the improvement of instruction in science in the elementary school.

Emphasis is placed on the concept that the purpose of elementary school science instruction is to aid children in making positive adjustments to their environments by making reasonable interpretations of natural phenomena. Science should be viewed as serving children and the total democratic society, rather than society viewed as serving science. Since all citizens in a democracy are responsible in determining how the results of scientific investigations shall be utilized, the elementary school curriculum must include science as a functional part of the developing individual's life.

The results of several research studies indicate that children at all age levels employ portions of the scientific method in their attack on problems. They weigh evidence, pose

hypotheses, suggest experiments, observe and form conclusions. For this reason, the same general objectives may be used for all children in the elementary school, what each child will achieve at his own level of comprehension being taken into account.

In evaluating outcomes of a programme in science, the teacher of elementary-school children is urged to make a careful study of the behaviour of children. This behaviour should be considered in relation to the social values associated with the development of science in a democratic society.

42. Ragan, William B. Modern elementary curriculum. New York, Dryden Press Inc., 1953. 570 p.

This book on general curriculum practices in the elementary school devotes some forty pages to "Exploring the natural environment -- science." In this section, the author points out that young children are investigative, have a wide range of interests, should be encouraged to use imagination, learn through many types of experiences.

In considering the place of science in the elementary-school curriculum, it is well to remember that the persistent problems of everyday living - health, safety, and the elimination of superstitions and ignorant practices - require a knowledge of science for their solution. In addition, engaging in science experiences helps children understand more fully the democratic way of life since democracy employs the method of experimentation, promotes equality of opportunity, requires active participation in planning and carrying on activities, involves faith in people, means respect for human worth. All these factors are part and parcel of an active, effective programme in elementary science.

Teachers are urged to provide a continuous, well-planned but flexible sequence of science experiences for children. A programme composed of haphazard and incidental activities will not provide satisfying science experiences for children at any age level.

In evaluating the worth of a programme in science, teachers are advised to observe the behaviour of children as closely as possible. In doing so, they will become aware of whether or not a child is improving in his ability to attack and solve a problem is becoming more responsible, is better able to work effectively with others, is more open to the ideas of others, is critical of his ideas as well as those of others, and is improving in his ability to gather evidence before reaching a decision.

43. "Using what we know about children --- science learnings". Childhood Education, Volume 26, No. 7, pages 294-323. Washington, D.C., March, 1950.

The major part of this issue of Childhood Education is devoted to science in the elementary school. The leading articles(1) make two points: first, children must be led to become so aware of and secure in the concept of change that they fully understand change to be a constant factor in the environment, and second, science make a difference in the lives of children if we see children growing in ability to understand their environments, thinking through problems more carefully, and gaining a fuller appreciation of the world about them.

One of the articles(2) analyses the needs of the developing child and suggests ways in which science experiences offer him rich opportunities to explore, to satisfy physical needs, to associate with other children, to have outlets for his imaginative life, and to be recognized as an individual. Teachers are urged to keep science in the elementary school active and not allow it to become a "bookish" subject.

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(1) Glenn O. Blough "What difference does it make?" and Katherine E. Hill, "Toward understanding and security".

(2) Ralph C. Preston, "Using what we know about children in developing science learnings".

Three other articles[1] describe fruitful experiences for nursery-school-age children, children of ages five to nine, and children of ages nine to twelve. In addition, one article[2] is devoted to materials which could be used in science experiences, and another[3] is devoted to the science museum and the way it functions in a school system.

A final article[4] describes the way in which a group of seven-year-olds experienced their environment in the autumn.

44. Wells, Harrington. Elementary science education in American public schools. New York, McGraw-Hill, 1951. 333 p.

This book for teachers consists of two parts: the first is devoted to theory and practice and the second to resource aids. The emphasis is on the biological aspects of elementary science. In Part I there are chapters dealing with methods, philosophy and administration, child growth, nature study in childhood, unit development, departmentalized science in the upper grades, the science laboratory and experiments with plants. In Part II visual aids, books and pamphlets, games, plays, graded reader apparatus and supplies are discussed.

45. Zim, Herbert S. Science for teachers and children. Washington, D.C., Association for Childhood Education International, 1953. 55 p.

Because of the great strides which have been made in science and in the understanding of children during the past few decades, it is possible to approach the problem of science in the elementary school from a new point of view. Emphasis is no longer placed on memorization of facts nor on mere identification of objects. Rather, acquisition of science content is the outcome of active discovery in science. This discovery or problem solving is not to be thought of as random activity on the part of children, but as work which is undertaken with the guidance of the classroom teacher. The teacher in such a programme is ever mindful of the developing attitudes and aptitudes of girls and boys as they have fruitful experiences in elementary science.

The major portion of this bulletin gives excellent, practical suggestions concerning the place of science in the daily programme, materials for teaching science, science books and magazines for children and teachers, and the use of the community in science teaching. The final chapter of the pamphlet is devoted to descriptions of science experiences of five classroom teachers with their groups of children.

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(1) Ethleen Daniel, "Science experiences for the up to nines".
Beatrice J. Hurley, "Science experiences for nines to twelves".
O. J. LuPone and Edward P. Powers, "Science in the nursery school".

(2) Glenn O. Blough and Paul E. Blackwood, "Materials for solving science problems".

(3) Catherine Dillon, "The museum with a voice".

(4) Bernice T. Stroetzel, "How geneseo prepares for winter".

## SAMPLE ELEMENTARY SCIENCE TEXTS AND MATERIALS


Anscieau, Gilbert. Le familier de la mer. Paris, Presses d'Ile-de-France, 1951. 268 p.

Auriac, C. "L'Enseignement Scientifique" in L'école exemplaire; initiatives et suggestions. Paris, A. Colin, 1948. 330 p.

Basic science education series. Evanston, Ill., Row Peterson and Co., 1942-46. 7 vols.

Beauchamp, W.L., Blough, Glenn O. and Williams, Mary. Basic studies in Science; curriculum foundation services. Chicago, Scott Foresman and Co., 1946. 9 vols.

Bjerk, Asbjorn. Dyreboka. Zoologi for folkeskolen. Oslo, Gyldendal, 1954. 134 p.

Björlykke, Knut Olai. Norske planter. Skoleflora med bilder en kortfattet plantelaere. Oslo, A.W. Brøggers bokts, 1952. 189 p. illus.

Carpenter, Harry A. et al. The rainbow readers; adventures in science. Boston, Allyn Bason and Co., 1944-46. 6 vols.

Craig, Gerald S. et al. Our world of science. New York, Ginn and Co., 1950. 8 vols.

Crammer, J.L. The popularization of science through cheap books. Paris, Unesco, 1949. 15 p. (NS/69).

Daniel, F. Health science and physiology for tropical schools. London, Oxford University Press, 1953. 304 p.

Dowling, Thomas et al. Understanding science series. Philadelphia, John C. Winston Co., 1951. 6 vols.

Dumas, Louis. Au pied du mur. Paris, Bourrelier, 1948. 244 p.

Eiklid, Olav. Plantelaere for fokeskolen. Oslo, Gyldendal, 1952. 81 p. illus.

Ekman, Walter and Englund, B. Kemiundervisningen. Studieplan för 8:e och 9:e skolaren. 12 p. (Studieplaner ... 1946 års skolkommission)

Flood, W.E. Science in the modern world series. London, Longmans, 1948. 7 vols.

Frazier, G.W. et al. The scientific living series. Syracuse, L.W. Singer and Co., 1937-40. 8 vols.

Fuzier, M. "L'enseignement scientifique à l'école primaire; les expériences". L'Ecole publique, No. 28, octobre 1951. pp. 5-6.

"Histoire de l'astronomie". Bibliothèque de travail, No. 312, mai 1955. Cannes, 24 p.

Holmsen A. and Ström, O. Naturhistorie. Dyre-og plantelaere. Oslo, Cappelen, 1953. 175 p.
_____. _____. Naturkunnskap for folkeskolen. Bokmål og nynorsk. Oslo, Cappelen, 1952. 280 p. illus.
_____. _____. Naturlaere for folkeskolen. Oslo, Cappelen, 1953. 118 p.

Johnstone, Mary A. Science in the school garden. London, MacMillan, 1951. 176 p. illus.

Joliot-Curie, F. L'enseignement scientifique. Paris, Bourrelier, 1940. 98 p.

Jolly, René. Les sciences appliquées à laclassed'études primaires. Paris, Fernand Nathan, 1948. 464 p.

Knox, Warren et al. Wonderworld of science. New York, Charles Scribner's Sons, 1940-41. 6 vols.

Life and science series. London, Methuen and Co. Ltd. 10 vols.

Lindhe, Gustaf. Studieplan i kemi för enhetsskolan vid pedagogisk för-söksverksamhet i överensstämmelse med beslut av 1950 års riksdag. Stockholm, Almqvist & Wiksell, 1952. 48 p. (Studieplaner ... 1946 års skolkommission)

Linell, Tore. Biologi med hälsolära. Studieplan för 7:e och 9:e skolaren. Stockholm, Svenska bokförlaget, Norstedts, 1952. 30 p. (Studieplaner ... 1946 års skolkommission)

Madras, Department of Public Instruction. Guide book to the teaching of science in schools; forms 1 to 3. Madras, 1950. 31 p.

Mallinson, George Greisen and Mallinson, Lois Marion. A bibliography of reference books for elementary science; revised edition. Washington, D.C., National Science Teachers Association, 1954. 42 p.

Michelsen, Børge. How to conduct a science fair. Paris, Unesco, 1949. 17 p. (NS/PSl/4).

Paniel, M. "Les méthodes actives dans l'enseignement des sciences naturelles". Bulletin de la Société française de Pédagogie., No. 92, 1951. pp. 47-60.

"Pédagogie et pratique de la classe." L'Education africaine, pp: 53-98, Vol. 43, No. 29, 1955. Dakar, Service Pédagogique, Direction générale de l'Enseignement.

Richard, A. Histoire naturelle élémentaire en cahiers. Paris, Fernand Nathan, 1951. 3 vols.

Richardson, John S. Introduction of experimental science in the elementary and secondary schools of the United States. Paris, Unesco, 1950. 25 p. (NS/PSl/9)

Saunders, H.N. The teaching of general science in tropical secondary schools. London, Oxford University Press, 1955. 379 p. (Unesco handbooks on the teaching of science in tropical countries, vol. 7)

Science at work series. London, Oxford University Press, 1947-49. 3 vols.

Science teaching techniques. London, John Murray, 1952. 63 p.

Sedström, Ernst. Studieplan i fysik för enhetsskolan. Stockholm, H. Gebers förlag, 1952. 95 p. (Studieplaner ... 1946 års skolkommission)

Serrano de Haro, Agustín. Un regalo de Dios; el libro de primer grado de ciencias de la naturaleza. Madrid, Editorial Escuela española, 1955. 107 p. illus.

Simple science in simple English series. London, Oxford University Press, 1937. 17 vols.

Smith, Victor C. et al. Science for modern living. Philadelphia, J.P. Lippincott Co., 1951. 9 vols.

Swiss Association of Science Teachers. The teaching of science in elementary and secondary schools in Switzerland. Paris, Unesco, 1950. 14 p. (NS/PSl/10)

"Techniques Freinet dans une classe unique à tous les cours". Brochures d'éducation nouvelle populaire. Nos. 70-72, mars, avril, mai 1952. Cannes, éditions de l'école moderne française. 52 p.

Todd, K.W. A first tropical nature study, by Lucy Deakin. London, Longmans, 1951. 117 p.

Verel, L. "L'emploi du livre dans l'enseignement scientifique à l'école primaire". Bulletin de l'école pratique de psychologie et de pédagogie. Vol. 8, No. 6, mai 1953. pp: 488-491. Université de Lyon.

Williams-Ellis, Amabel. The popularization of science through books for children. Paris, Unesco, 1949. 18 p. (NS/PSI/7).

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